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**PC Simulation:
Proposed Categorization, Architecture and Business
Case Analysis**

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1.0 Introduction

The Navy is preparing to make significant near-term investments in PC Simulation. This document is intended to

- articulate the definition of PC Simulation as it will be applied to Navy acquisitions
- determine when PC Simulations should and should not be considered to meet a specific training need
- Propose a standardized categorization for PC Simulations for both Navy and PC Simulation vendors
- Propose standardization through a common operating environment and architecture for PC Simulation development and deployment to meet the majority of here-in categorized PC Simulations.

1.1 Background

A specific finding from a Naval Operations (OPNAV) funded and Commander, Fleet Forces Command (CFFC)-directed analysis completed April 2002 was a need to “use PC-based simulation to support training objectives that don’t require full mission trainers, at much lower cost, and are more likely to be deployable for use to refresh perishable skills”. There was an underlying theme that schoolhouse simulations could be re-used to support individual training during pre-deployment work-ups if they were configured like the Fleet systems. PC-based simulations that are re-configurable and deployable on IT-21 compatible microcomputers aboard ship would meet the Fleet requirement and enhance relevance, quality and timeliness of training. Baseline Assessment Memorandum (BAM) 04 projected savings and cost avoidances of \$59M in Tactical Training Equipment (TTE) maintenance costs over the Future Year Defense Programs (FYDP). PC-Simulation will be employed to reduce or offset TTE maintenance costs.

1.2 Purpose

This document is intended to provoke thought and discussion, and to solicit comments for correction or enhancement on the topic of PC Simulation. The purpose of this document is to build consensus within and between government and contractor training product developers for PC-based simulation. Topics addressed include:

- PC Simulation Definition
- Lines of demarcation between PC Simulation and other types of simulation products
- When it is appropriate to consider PC Simulation as a means of meeting a training need.
- Categorization of PC Simulation in terms of fidelity and complexity
- A PC Simulation Common Operating Environment (COE)
- A Proposed Approach for a Standard Architecture for specific categories of PC Simulation
- An applied Business Case Analysis and Return on Investment (ROI) for PC Simulation products.

2.0 Discussion

2.1 PC Simulation Defined

This document does not discuss high-end simulations such as flight simulators or total immersion simulators; rather, it focuses on simulations designed and executed on personal computers that can be used to enhance training products.

2.1.1 Definition for Simulation:

Department of Defense (DOD) defines a simulation as a model that represents activities and interactions over time. A simulation may be fully automated (i.e., it executes without human intervention), or it may be interactive or interruptible (i.e., the user may intervene during execution). A simulation is an operating representation of selected features of real-world or hypothetical events and processes. It is conducted in accordance with known or assumed procedures and data, and with the aid of methods and equipment ranging from the simplest to the most sophisticated.

A model may be defined as a representation of some or all of the properties of a device, system, or object. There are three basic classes of models: mathematical, physical, and procedural.

A mathematical model is a representation comprised of procedures (algorithms) and mathematical equations. These models consist of a series of mathematical equations or relationships that can be discreetly solved. Usually the models employ techniques of numerical approximation to solve complex mathematical functions for which specific values cannot be derived (i.e., integral).

A physical model is a physical representation of the real world object as it relates to symbolic models in the form of simulators.

A procedural model is an expression of dynamic relationships of a situation expressed by mathematical and logical processes. These models are commonly referred to as simulations.

PC Simulation Defined:

For purposes of discussing the topics within the context of this document, PC Simulation is defined as:

A desktop or laptop computer software program that strives to mimic a phenomenon, experience, equipment or environment that is based on reality (purposely excludes fantasy games). The PC Simulation, when applied to a training domain, serves to provide the user with the opportunity for learning in a robust, motivating, and engaging environment, wherein the presentation of the material is affected by a high degree of user interactivity and where context and practice are key to learning.

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2.1.2 Lines of Demarcation for Simulation

It is anticipated that PC Simulation can be applied to meet the need for a significant number of training needs. In order to differentiate PC simulation from other types of simulation technologies, Part-task training devices, MicroSIM devices and Full-up Simulation Systems are defined:

2.1.2.1 Part-Task Trainers

A Part-task training device permits selected aspects of a task to be practiced independently of other elements of the task. Its purpose is to provide economical training on certain elements requiring special practice which are not dependent upon the total equipment (system). ...*To be expanded after Industry Days Conference*

2.1.2.2 MicroSIM

MicroSIM uses training devices based on low-cost, PC-based gaming and simulation techniques. It uses commercial off-the-shelf software for visual and modeling and usually does not provide motion cues. ...*To be expanded after Industry Days Conference*

2.1.2.3 Full-up Simulation Systems

A full-up simulator recreates aural, visual, and motion cues of the target system by employing a sophisticated visual system, a high-fidelity motion system, and realistic instruments. This type of system usually incorporates as many functional mock-ups of the actual system as possible to facilitate realistic training. ...*To be expanded after Industry Days Conference*

2.2 When to Apply PC Simulation to a Training Need

On the premise that ‘a picture is worth a thousand words’, we have learned over time that presenting learning material in various formats and taking advantage of multimedia technologies greatly benefits the learner.

The primary reasons for using PC Simulations in a learning environment become valuable tangible and intangible benefits for our Return on Investment (ROI). PC Simulations:

- Can significantly reduce training time and can mimic real time or non-real time events.
- Can better mimic the actual work environment, thus producing better retention of learned skills
- Can provide a safe environment for exercising ‘what-if’ scenarios or learning from one’s mistakes.
- Can allow learning to take place without the need for using expensive operational equipment, thus reducing life-cycle costs
- Allow the practice of hazardous procedures

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Simulation techniques can produce an even more robust and engaging learning experience, however, we must be cautious not to apply the technology for technology's sake. Better said, PC simulation will not meet all of our training needs, thus we need we need to apply PC simulation technologies only when there are valid reasons to do so.

One method of determining if PC Simulation is appropriate to meet the training objectives is to review a set of Learning Levels within the three Learning Types (Knowledge, Skills, and Attitudes). PC Simulation Training Categories (Section 2.3) will additionally assist in this determination. Once it is determined that PC Simulation is a potential solution from the perspective of the psychology of learning, additional rationale can be applied from Return on Investment (ROI) criteria (See Section 5).

2.2.1 Instructional Systems Design (ISD) Perspective

Appendix A contains a table that categorizes Learning Levels within the three Learning Types and Action Verbs with their definitions for each of the Learning Levels based on the psychology of learning. Each of the action verbs can be compared with job task lists, and training/learning objectives for a given identified training need. Using this approach it becomes clearer which learning levels could be considered appropriate for the use of PC Simulation products.

Table 2-1 synthesizes those Learning Levels that may benefit from applied PC Simulation

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Table 2-1 Sample Learning Levels Appropriate for PC Simulation Considerations

Learning Type	Learning Level	Description
Knowledge		The fact or condition of knowing something with familiarity gained through experience or association
	Discrimination Learning	Learning to group similar and dissimilar items according to their distinct characteristics.
	Fact Learning	The learning of verbal or symbolic information (e.g. names, formulas, facts)
	Problem Solving	Learning to synthesize lower levels of knowledge for the resolution of problems.
	Procedure learning	Learning to perform step-by-step actions in the proper sequence.
	Rule Learning	Learning to use two or more facts in a manner that will provide regularity of behavior in an infinite variation of situations.
Skills		The ability to use one's knowledge effectively and readily in execution or performance. Dexterity or coordination especially in the execution of learned physical tasks.
	Adaptation	Learning to modify a complex physical skill to accommodate a new situation
	Continuous Movement	Learning to track, make compensatory movements based on feedback.
	Perception	Perception of sensory stimuli that translates into physical performance.
	Readiness	Learning to have Readiness to take a particular action.
Attitude		A mental position with regard to a fact or state. A feeling or emotion toward a fact or state
	Competence	Learning and demonstrating the mental preparedness to make decisions by using prioritized strategies and tactics in response to normal, abnormal, and emergency condition cues associated with the performance of an operational procedure.
	Receiving	Learning and demonstrating the ability to perceive the normal, abnormal, and emergency condition cues associated with the performance of an operational procedure. Situational Awareness of operational condition cues.
	Responding	Learning and demonstrating mental preparedness to encode operational cues as indicators of normal, abnormal, and emergency conditions associated with the performance of an operational procedure.
	Valuing	Learning and demonstrating the ability to judge the worth or quality of normal, abnormal, and emergency cues associated with the performance of an operational procedure.

See Appendix A.

2.2.2 Types of Training Benefited by PC Simulation

PC Simulations can benefit any type of training wherein practice is required to become proficient at a skill. The more critical it is for the practice to take place in context, the more PC Simulations will benefit the training type. See Section 2.3 for more details of Training Types and Categories. Typical types of training that could benefit from PC Simulation are:

Table 2-2 Types of Training Benefited by PC Simulation

PC Software Simulations	
PC Application Tutorials	Tactical Workstation Application Tutorials
System Operator Training	Electronic Performance Support Systems
Procedural Simulations	
System/Equipment Operator Training	System/Equipment Maintenance Training
Just-In-Time (JIT) Refresher Training	Mission Rehearsal
Job Aids	What-if Scenarios
System Calibration Training	Safety Training
Time-based Training	Sequence Training
Electronic Performance Support Systems	
Situational Simulations	
Just-In-Time (JIT) Refresher training	Role-playing
Team Dynamics training	Collaboration training
Mission Rehearsal	Job Aids
What-if Scenarios	Interpersonal Skills, Soft-Skills Training
Decision-making Skills Training	Scenario/Case-based Training
Cognitive Support Simulations	
Complex Concepts training	Familiarization Training
Applied Theory Training	
Virtual Worlds	
Role-playing	Team Dynamics Training
Mission Rehearsal	Familiarization Training

2.2.3 Caveats

If PC Simulation techniques can produce an even more robust and engaging learning experience, why don't we make more frequent use of these technologies? Make no mistake, PC simulations are expensive. Focus groups chartered by Brandon-Hall¹ have estimated that typical development time for an e-learning course is around 220 hours of development for every hour of instruction. The development time required for PC Simulation is estimated to be at a ratio of 750-1300:1. Thus, based on development time alone, an *immediate* need for a training product precludes the use of PC Simulations;

¹ E-Learning Simulations: Tools and Services for Creating Software, Business, and Technical Skills Simulations , by the staff of brandon-hall.com, 2003.

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additionally, PC Simulations do not lend themselves to systems, equipment, process or situational training that frequently change.

2.3 PC Simulation Categories

PC Simulation can come in many forms ranging from simple animations to depict process or mechanism movement to high immersion virtual worlds. The purpose of categorizing PC Simulations is two-fold:

- Provide a basis for development costs associated with varying levels of fidelity, interactivity and immersion
- Provide a common language of the intended applied training technologies between Navy acquisition and vendor offerings

An aggregate of PC Simulation categories is provided in Section 5.4.

2.3.1 PC Simulation Types

The PC Simulation Types listed in Table 2-2 were derived and slightly modified from the aforementioned Brandon Hall study. PC Simulation types under consideration are:

• Cognitive Support Simulation	• PC Software Simulation
• Situational Simulation	• Procedural Simulation
• Virtual Worlds	

The PC Simulation Types bring different requirements for separate yet inter-related consideration of the following issues:

- Fidelity
- Interactivity
- Immersion
- Applied training technologies
- Delivery Mechanism (Media)

See the following Sections for more discussion on these issues.

2.3.1.1 Cognitive Support Simulation

Based on the principle of “a picture is worth a thousand words”, Cognitive Support Simulation assists in modeling complex concepts to assist the mental process or faculty of knowing --including aspects such as awareness, perception, reasoning, language, memory and judgment. These types of simulations can range from simple graphic animations to complex 3D models. The goal of Cognitive Support Simulations is to assist learners acquire, organize, and apply knowledge. These simulations usually rely upon motion to better explain complex concepts; are perhaps the simplest to construct; and lend themselves to re-use in various training products.

2.3.1.2 PC Software Simulation

PC Software Simulation can be used to demonstrate step-by-step instructions on using an application resident on a PC. With X-Window viewers, this model can be extended to capturing still screen shots of Unix-based workstations in order to demonstrate the use of applications in other environments, for example, C4 systems (GCCS, TBMS, etc.). Developing these types of PC Simulations is for the most part simple and inexpensive. These simulations can range from simple demonstrations of applications intended for passive observation through highly interactive lessons which engage the learner to practice their skills in using PC Software. Combining this type of PC Simulation with techniques from Procedural Simulation could provide refresher System/Equipment Operator training.

2.3.1.3 Situational Simulation

Situational simulations are typically developed to assist learners in problem solving, soft skills and team dynamics training and are usually based on role-playing simulations and case-based scenarios. Situational Simulations are ideal for Mission Rehearsal. *Learners are typically members of the environment in these simulations, rather than being some external force that manipulates variables at will. They typically incorporate situations in which participants react to many decision alternatives and feature a best—or optimal—sequence of right or wrong decisions (Brandon-Hall).*

Situational Simulations will likely use complex flowcharts or state tables to map out the desired role-playing scenarios. When using Situational Simulation for team coordination and collaboration training wherein human interaction is critical to mission rehearsal, augmentation with audio/video collaboration tools would be desirable.

2.3.1.4 Procedural Simulation

Procedural Simulations are ideal for systems/equipment operator and maintainer training. Start-up procedures, task sequence and other drill and practice procedural training are ideal candidates for Procedural Simulation. This type of PC Simulation is ideal for potentially replacing Tactical Training Equipment (TTE) in Navy School houses. Procedural Simulations afford a safe, realistic environment to resemble the actual experience of systems/equipment operation and maintenance as closely as possible, and allows the learner to immediately see the results of their actions (learning by making mistakes).

These simulations can be designed to use very advanced state tables, variable tracking and triggers that change the states of the modeled system/equipment as the learner performs various activities. The costs for developing Procedural Simulations are directly proportional to the level of fidelity, interactivity and student/instructor control over the objects, events, and pre-programmed faults in addition to the number of system/equipment functions, objects, faults, and feedback mechanisms modeled. See Section 2.3.2 for discussions on fidelity and interactivity issues.

2.3.1.5 Virtual Worlds

A Virtual World simulation is likely to involve navigation in a synthetic space. Using a photo-realistic computer-generated interactive environment, these simulations strive to achieve the same sense of space as in the real world through motion and visual cues. Subjective measures based on human spatial perception supplementary to accurate geometry, illumination, and task performance, reveal the actual cognitive mechanisms in the perception of a virtual environment that are not otherwise apparent. See Section 2.3.2.3 for limitations on the desired immersion techniques applied to this PC Simulation type.

2.3.2 Common Terminology

Section 5.4 will provide a categorization of PC Simulation based on the common terms listed in this section. Government and PC Simulation vendors are invited to add to or modify this terminology for the purpose of more clearly defining the PC Simulation categories.

2.3.2.1 Fidelity

Fidelity is the accuracy of PC Simulation object representation when compared to the real world. Generally, the higher the fidelity required for the training product, the higher the development costs.

Low Fidelity

Technologies such as still graphics with transitional effects and/or vector-based animation mimicking a real-world phenomenon or environment provide the trainee simple concepts or basic familiarization. These types of simulation usually move in a linear fashion and require little or no user interaction. For example, the inter-workings of an aircraft engine are presented to an aircraft engine maintainer using vector-based animation with cross-sectional views of the internal components. Audio/Video modules can be added enhance the learning experience.***To be reworked after Industry Days Conference.***

Medium Fidelity

This category involves a higher degree of user interactivity which affects the path and outcome of the training. Technologies could include 2D and 3D animation. User interactions are usually comprised of performing simple to moderately difficult tasks. As an example, a 2D or 3D model could be used to simulate systems/equipment where the trainee needs to perform a certain set of procedures for the situation. Audio/Video modules can be added to enhance the learning experience.***To be reworked after Industry Days Conference.***

High Fidelity

Technologies in this category could involve complex equipment modeling with events and fault conditions or immersion technology. The user is given an increasing level of control over the simulation. Training scenarios can be complex and require the user to process a large amount of information. Closely mimicking the context of the work

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environment is the goal with this type of fidelity. This category can use elements from the other categories.*To be reworked after Industry Days Conference.*

2.3.2.2 Interactivity

For the purpose of categorizing PC Simulation, interactivity has several forms:

- Hierarchical interactivity
- Support Interactivity
- Object interactivity
- Construct interactivity
- Simulation interactivity
- Non-immersive contextual interactivity

Hierarchical Interactivity

Varying levels of hierarchical interactivity provide the learner the ability to navigate through the domain-knowledge representations. This form of interactivity gives the learner control in exploring the subject in a self-driven mode. The associated hierarchical interactivity mechanisms could be menus, hyper-links, navigational bars, structured listings, XYZ-coordinates, value setting/scroll bars, axial rotation, zooming, etc.

Support Interactivity

Support interactivity describes the afforded feedback mechanisms and performance support to learner reactive inquiry (context sensitive and insensitive). The complexity of support interactivity could range from a context insensitive or context sensitive reference system (help file) to requirements that could be considered for incorporation as an Electronic Performance Support System (EPSS).

Object/Construct Interactivity

Object interactivity affords the learner a means of proactive inquiry. This type of interactivity engages the learner in manipulation of real world representations of the objects (buttons, dials, radial boxes, people, things etc.) that are activated by an input device such as a mouse. Construct interactivity requires the creation of an instructional environment in which the learner is required to manipulate component objects to achieve specific goals and contains a feedback as a result to a learner response to a generated problem. Generally, the more complex the modeled object behaviors and faults, and more the number of objects modeled, the more complex and expensive the training product development.

Simulation Interactivity

Simulation interactivity is the ability to simulate several aspects of the real world in a realistic and highly representative way. The learner (or more likely, an instructor) should be able to: select what aspects to include/exclude in the simulation and set the modeling parameters and characteristics. The simulation's robustness and real-time response are crucial elements of this type of interactivity.

Immersive Contextual Interactivity

This concept combines and extends the various interactive levels into a complete virtual training environment in which the learner is able to work in a meaningful, job-related

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context. See 2.3.2.3 for the intended limitations of immersion for this category of interactivity.

2.3.2.3 Immersion

Immersion can be defined as: complete attention; intense mental effort; absorbed, or engrossed. To engage the learner, there is a need for 'learning by doing.' The more the PC Simulations engage the learner, the higher the level of immersion applied to the intended learning objectives. The level of immersion for PC Simulations can additionally be tied to both interactivity and fidelity.

The PC Simulation domain for the purposes of this paper and planned Navy acquisitions limits immersion technologies to the following categories:

Level I –Desktop Immersion

Besides the monitor used to display images stressing the portrayal of job context and audio augmentation, no other sensorial output is used. "Traditional" computer applications could be put in this category.

Level II –Limited Multi-sensory output devices

Incorporates specialized displays, earphones, and tactile or force feedback devices only when critical for meeting specific requirements of the training objectives.

Note: Mission rehearsals or any team dynamics training requiring collaboration or role playing among the participants that are augmented and coordinated with audio/visual tools are included in this level of immersion.

The PC Simulation domain, as defined, does **not** include attempting to provide the illusion of being inside the simulated environment (levels of presence), nor does it include 'fish tank' immersion achieved with providing stereoscopic images and tracking the user's head or direction of sight in order to simulate a motion parallax effect.

2.4 Training Technologies

PC Simulations are intended to be deployed using several training technologies. Ideally, PC Simulations provided by vendors would be so designed to be capable of deployment on multiple Training Technologies listed. Each training technology has different impact on delivery fidelity, media, Learning Management System (LMS) and Computer-Managed Instruction (CMI). These topics are discussed within.

The training technologies intended to be used for PC Simulations follow:

Electronic Classroom Asynchronous (ECA)

This environment is afforded to Navy learners having access to Navy Advanced Electronic Classrooms (AEC) wherein an instructor-facilitator model is used vice an instructor-led training model. Learning Resource Centers (LRC) also fall under this category. PC Simulations developed for ECA will need to make use of a highly granular CMI and will have little or no specific LMS requirements.

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Electronic Classroom Synchronous (ECS)

This environment is afforded to Navy learners having access to Navy Advanced Electronic Classrooms (AEC) wherein an instructor-led training model is used. PC Simulations developed for ECS will need to make use of a minimal CMI and will have some LMS requirements. More importantly, the PC Simulation used in the ECS environment would ideally give control to an instructor on selecting pre-programmed faults, features, and object parameters to tailor the lesson to individual students and take advantage of other AEC functionality.

Stand-alone PC

Taking courseware on a stand-alone PC allows the learner ultimate control over self-paced lessons. This type of training technology is also known as Interactive Courseware (ICW) or sometimes Interactive Multimedia Instruction (IMI). PC Simulations developed for PC is advantageous in that the learner can make use of the instruction virtually anytime, anywhere, but there are some disadvantages that need to be considered.

- Most PC Simulation developed for stand-alone delivery has not in the past provided a means of linking student accomplishments to the Navy LMS. Any future PC Simulation provided in this media would need to report student progress, scores, completion, etc., to the Navy LMS
- Distribution mechanisms can be unnecessarily expensive and unwieldy.
- With many Navy PCs being converted to the Navy Marine Corps Intranet (NMCI), users can no longer install this type of courseware to their desktop computers. Future PC Simulations delivered for stand-alone PCs will need to be self contained and will need to execute from the CD-ROM vice relying on transfer of files or run-time executables to the desktop. See Media Considerations, Section 2.5.

Internet Delivery

Any PC Simulation destined to be delivered via the Internet will likely be installed on the Navy E-Learning site and integrated with the Navy LMS and LCMS. Shareable Content Object Reference Model (SCORM) conformance will also be a requirement. Bandwidth limitations may limit the level of fidelity in these products, but should not limit the level of interactivity afforded. It is anticipated that Internet and Intranet delivery of PC Simulations will need to take advantage of Mobile Code technologies and web browser based self-contained application technologies to provide increasing levels of fidelity and interactivity. See Section 3.3.

Intranet Delivery

Intranet Delivery of PC Simulations can increase the level of fidelity applied over Internet delivery and approach the level of fidelity that can be derived from Stand-alone PC, ECA, and ECS. With this type of delivery, it is anticipated that training modules will be installed on ship-board and shore-based Navy servers that may or may not contain a distributed installation of the Navy LMS.

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Collected results for student tracking must later be updated to the Navy E-Learning site LMS. It is anticipated that Internet and Intranet delivery of PC Simulations will need to take advantage of Mobile Code technologies and web browser based self-contained application technologies to provide increasing levels of fidelity and interactivity. See Section 3.3.

Other

Personal Digital Assistants (PDA) could be considered for some types of PC Simulation if the platform is available in the intended training environment. The PC Simulation would need to include a mechanism for updating any collected results for student tracking back to the Navy LMS in the case of an actual training course is being deployed vice an implementation of a simple job performance aid or refresher module.

2.4.1 Multimedia Augmentation

Multimedia augmentation is critical for providing job-related context, engagement and motivation. Most forms of PC Simulation will benefit from the addition of robust still and animated graphics in addition to the use of audio and live video products. Graphics animation and simulation comes in many forms. Simple animations can be created in Web-based training products using the Graphics Intermediate File (GIF98a) format or Macromedia FlashTM type technologies.

A series of pictures (photographs) can now be displayed in similar fashion with fade-in and fade-out techniques to mimic animation, using the Synchronized Multimedia Integration Language (SMIL) to greatly enhance training products. This process makes use of a series of still graphical images displaying them in a continuous timed loop synchronized with other media elements (text, voice, etc.). These files could be used to augment many training products to enhance the learning process.

Additionally, audio and video augmentation is critical to the Situational Simulation type and should be used for any synchronous PC Simulation involving more than one learner.

For a complete list of acceptable graphic formats, movie formats and use of SMIL see the Navy E-Learning Content Technical Specifications currently available at:

http://www.navylearning.com/cnetdoc/Content_Tech_Spec3.pdf

2.5 Media Considerations

Delivery Fidelity

CD/DVD Servers with or without distributed LMS function

CD-ROM/DVD –must report back to the LMS –distribution issues

Web-based Synchronous –LMS ties...

Web-based Asynchronous

.....*To be completed after Industry Days Conference*

3.0 PC Simulation Architecture

The Navy has two primary goals for future procurements of PC Simulations –a move towards industry standards and the re-use of learning content objects. This section describes the proposed architecture and the use of standards. See Section 4 for issues on the re-use of learning content objects.

3.1 Target Platform

3.1.1 Target Hardware Platform

The target platform for executing PC Simulations is the Navy Information Technology for the 21st Century (IT-21). The IT-21 platform minimally meets and usually exceeds the industry standard Multimedia PC Council recommendations, thus PC Simulations require no special considerations from an aspect of hardware design and integration. The Navy is transitioning to the NMCI infrastructure, and the NMCI workstation configurations far exceed that of IT-21. PC Simulation vendors should ensure that their content can be executed on the target hardware platforms. The **minimum** target hardware platform is comprised of:

- IBM compatible PC
- Microprocessor Speed: Pentium 400 MHz
- Hard Drive: 6GB
- RAM: 64 MB
- Modem Speed: 56kbps
- Sound Card: 16 bit
- Speakers
- CD-ROM Drive: 12x
- Monitor display resolution range: 640 x 480 to 1024 x 768
- Color Depth: 24 bit
- Fonts: Small

3.1.2 Target Software Considerations

The target operating system for the IT-21/NMCI platforms are Microsoft Windows 32-bit. The target Middleware solutions, if needed, are Component Object Model (COM), Component Services (COM+), and Distributed COM (DCOM). The target data access models are Data Access Objects (DAO), ActiveX Data Objects (ADO), Microsoft Data Access Components (MDAC), Open Database Connectivity (ODBC), and Extensible Markup Language (XML) with Simple Object Access Protocol (SOAP) support.

3.1.2.1 Anonymous Browsers

For PC Simulations intended for delivery within a Web-based browser, vendors should target Microsoft Internet Explorer version 5.5 or greater and Netscape Navigator version 6.0 or greater. Whenever practical, PC Simulations should support BOTH browsers. When not possible to derive the same functionality in both browsers, the PC Simulation courseware must explicitly notify users which browser is compatible.

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3.1.2.1.1 Currently Supported Browser Plug-ins

Currently supported versions of Browser plug-ins supported by NMCI and the Navy E-Learning site are:

- Real Player version 8.x
- Windows Media Player version 7.0
- Adobe Reader version 4.05
- Macromedia Shockwave version 8.0
- Macromedia Authorware Web Player version 5.1
- Macromedia Flash Player 5
- Apple QuickTime Movie and Audio Viewer version 4.0
- IPIX version 6.2

Newer versions of the listed plug-ins are under consideration. PC Simulation vendors wishing to introduce alternative plug-ins for their products will need to submit the products for testing. See 3.1.3.

3.1.3 NMCI Considerations

NMCI lockdown policies will allow the PC Simulation applications to write to its own area of a workstation disk with administrator privileges during install but then must refrain from writing to restricted portions of the registry or other non-authorized areas of the disk at runtime. PC Simulation products that are intended to run on the NMCI environment must get proper approval and be subjected to appropriate testing. See the Navy Enterprise Application Development Guidelines, Supplement A, currently available at: https://nmci.navair.navy.mil/war_room/Rel_Dev_DeploymentGuide.pdf

3.2 Industry Standards

3.2.1 Real-time Distributed PC Simulation Applications

Those PC Simulations requiring real-time distributed applications across Local Area Networks (LAN) or Wide Area Networks (WAN) or integration of a mix of PC Simulations should target Distributed Interactive Simulation (DIS), High Level Architecture (HLA) or for web-based implementations, Extensible Modeling and Simulation Framework (XMSF) technologies.

3.2.2 Proprietary Solutions and Proprietary Run-time Environments

Future Navy PC Simulation procurements will stress the use of industry standards and avoid vendor proprietary solutions and proprietary run-time engines –especially those requiring an associated licensing fee.

3.2.3 SCORM

The Shareable Content Object Reference Model is a standard that the Navy will embrace and enforce on future training product deliverables.

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The intent of SCORM is to focus on *sharing* course content developed for:

- embedded training
- job performance support systems
- training simulations
- intelligent tutoring systems
- stand-alone Web and self-paced courseware

As training courses are being developed, SCORM allows the developer to ‘tag’ various objects for re-use—thus reducing duplication of effort. SCORM also provides a means of using disparate course development toolsets, Learning Management Systems (LMS), Course Management Systems (CMS), and Learning Content Management Systems (LCMS).

3.3 A Proposed PC Simulation Architecture

Although not appropriate for every type of PC Simulation product, it is believed that an adequate level of fidelity, interactivity, and immersion, and the ensuing desire to provide robust, engaging and motivating training content can be met with the use of anonymous browser technologies. The Navy is proposing that PC Simulation vendors migrate towards this standardized architecture whenever possible. Browser-based technologies are ubiquitous, platform independent, and are becoming increasingly more robust in their delivery of media rich content. Using browser-based technologies, PC Simulation can be delivered, albeit with varying granularity of fidelity, via all previously listed training technologies: ECS; ECA, Stand-alone PC, Intranet, Internet, and PDA. To achieve this media-rich environment within browser-based products, mobile code technologies will need to be deployed.

3.3.1 Mobile Code Technologies

With mobile code, we can add robust multimedia that motivates learning through simulation, animations, practical embedded applications, etc. The reason mobile code is being applied to Advanced Distributed Learning browser-based training products is to better communicate to students the intended learning objectives through multi-sensory stimulation and interactivity. These techniques are intended to maintain student interest and the motivation to learn outside of the traditional classroom. Mobile Code offers a better means of engaging the learner.

Lately, training content vendors have shied away from using mobile code technologies because of recent DOD Guidance on using mobile code. The need for mobile code technologies being critical to Navy training is well documented. NETC Chief Information Officer (CIO) or NAVAIR Orlando PDSE can provide development guidelines for vendors to ensure that mobile code is safe from both maliciousness and exploitable vulnerabilities. The Navy Integrated Learning Environment Team (ILE) within NETC is also a good source for any issues relating to the use of mobile code technologies. A list of mobile code technologies is provided in Table 3-1.

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Table 3-1 Mobile Code Technologies

ActiveX	VBScript	Active Server Pages (ASP)
Windows Scripting Host (WSH) –when used to execute mobile code	Portable Document Format	Cold Fusion Markup Language (CFML)
UNIX Shell Scripts –when used to execute mobile code	Shockwave/Flash	Hypertext Preprocessor (PHP)
Disk Operating System (DOS) Batch Scripts –when used to execute mobile code	Extensible Markup Language (XML)	Server Sided Include (SSI)
Java Applets and other Java Mobile Code	Synchronized Multimedia Integration Language (SMIL)	Server-sided JavaScript
Visual Basic for Applications (VBA)	Quicktime	Server-sided LotusScript
LotusScript	Virtual Reality Markup Language (VRML) – exclusive of any associated Java applets or JavaScript scripts.	Java Remote Method Invocation (RMI)
PerfectScript	Java servlets	Java Network Device Connection (JINI)
Postscript	Java Server Pages	
JavaScript (including Jscript and ECMAScript variants)	Common Gateway Interface (CGI)	

3.3.2 Application Execution within Anonymous Browsers

Two industry standard development architectures receiving interest are the Microsoft .NET environment and the Sun Microsystems Java 2 Enterprise Edition (J2EE) using Java Web Start. Each system provides the ability to develop applications that will run within the browser envelope far surpassing current mobile code technology capabilities in terms of fidelity, interactivity and immersion techniques. Each of these systems requires a runtime environment that is currently not supported on the NMCI platform. The NETC ILE will be requested to push for approval of these technologies on the Navy E-Learning Site and NMCI seats. This technology further justifies the Navy's desire to move towards the browser-based architecture for delivering PC Simulations wherever possible.

3.3.3 Benefits of the Proposed Architecture

The move towards this standardized PC Simulation architecture has significant benefits:

- Browser technology is ubiquitous
- Supports multiple media deployment options
- Supports multiple platform deployment options
- Supported by the SCORM

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- Supports granular meta-tagging of Source Content Objects
- Promotes content re-use
- More easily integrated into Learning Content Management Systems (repositories)
- More easily integrated with multiple Learning Management Systems

4.0 LMS, LCMS, CMS and SCORM Issues

4.1 Learning Management Systems (LMS)

The features of an LMS are best described in terms of conducting the business of a typical university. A Learning Management System must be able to publish a catalog of course offerings, provide a mechanism for course sign-up, checking for prerequisites, and must be able to maintain transcripts for its student population. The Navy currently has an enterprise-wide LMS in-place at NETC (Thing). Also in-place, are policies and requirements for SCORM conformance for courses placed on the Navy E-Learning site. Any future PC Simulation course being developed for the Navy E-Learning will be required to use SCORM meta-tags to link to the LMS.

4.2 Learning Content Management Systems (LCMS)

LCMS products, put simply, act as repositories for training course content. Herein lies the opportunity for SCORM to promote re-use of course content objects, however, the SCORM, by design, does not delineate the level or demarcation of training source content for these objects. See Section 4.4.1. It is the responsibility of the course designer to implement Source Content Objects to take advantage of SCORM and the ensuing repository to catalog, index and retrieve these objects for training course content re-use.

Navy is deploying Outstart Evolution TM as the LCMS of choice across the enterprise. PC Simulation vendors will be encouraged to develop granular Source Content Objects in such a fashion as to allow these objects to populate the Navy LCMS. Discussions on Intellectual Property, Data Rights and potential royalties for vendor-developed objects are warranted.

4.3 Course Management Systems (CMS)

The primary purpose of a Course Management System is to provide testing, remediation, and tracking the start and finish of various modules *within* the training course. CMS is also known as Computer Managed Instruction (CAI) or a Course Management Shell. The majority of CMS products offer collaboration tools: asynchronous discussion forums, audio/video chat, text chat, email facilities, etc. required for courses that are better taught with instructor facilitation and student interaction. Most CMS products have LMS functions; however, they may or may not be compatible with the Navy LMS. PC Simulation vendors will be required to provide minimal CMS functions within their courseware to pass-off information (book-marking, start date/time, completion date/time, grade, etc.) to the Navy LMS.

4.4 SCORM

SCORM provides the opportunity to tie course content to LMS features and for building repositories for course content re-use. The technology, the toolsets, and the standards are in-place to make training course content re-use a reality. The Navy intends to establish a concerted effort to adhere to the SCORM standards and require implementation during the development of training courses. The appropriate Source Content Objects (SCO) and associated meta-tags must be made available for content re-use in a repository and linking to the Navy LMS.

4.4.1 Categorizing Source Content Objects (SCO)

The key to making course content objects available for re-use is the proper use of SCORM meta-tags when the training course is being developed. In order to take advantage of SCORM, we must start using the SCORM meta-tags at the very beginning of the training course development cycle –course development. The only weakness in this requirement, thus far, is born of the SCORM itself, in that the levels of SCOs are not delineated, therefore, there are no standardized means of *consistently* applying meta-tags for use by a CMS, an LCMS and an LMS.

This requires:

- Development of a finite, standardized category of SCOs for consistent SCORM meta-tags to be used across Navy.
- Navy training course developers make proper use of SCORM meta-tags during development
- The use of ONLY ‘SCORM conformant’ training course development toolsets
- A repository capable of indexing, search and retrieval of SCOs using SCORM meta-tags.

Applying a standardized methodology for meta-tags is the key requirement. Navy would be best served to define and categorize a standard set of SCOs. NETC/NPDC has formed a group to address issues surrounding standardization of user training and courseware development for inclusion in the ILE.

As an example, SCO categorization could start with the following list:

- Course Level
- Course Objective
- Course Topic
- Course Lesson
- Course Element (picture, animation, simulation, etc.)

4.5 Delivery and Re-use of PC Simulation Objects

To be completed after Industry Days Conference

5.0 Conducting a Business Case Analysis for Applying PC Simulation to a Training Need.

5.1 Introduction

PC Simulation could be used in specific types of training over other alternatives such as live exercises or pedagogical delivery (classroom lecture) because of its potential cost savings, flexibility, and fidelity. It is often difficult to determine whether simulation is justified for training due to its high cost of development. Establishing an aggregated value for PC simulation is not a trivial task and calculating the return on investment (ROI) is essential when deciding the appropriateness of PC Simulation for training.

5.2 Methodology

To determine if PC Simulation is a candidate technology to meet a training need, follow the steps outlined below:

1. Establish a need from the Instructional Systems Design Perspective
2. Determine the minimal level of fidelity needed to meet the training need.
3. Determine the minimal level of interactivity needed to meet the training need.
4. Determine the minimal level of immersion needed to meet the training need
5. Determine the appropriate media format/delivery mechanism to meet the training need.
6. Select the appropriate category of PC Simulation for the training need.
7. Conduct a Return on Investment Analysis.

...Decision Trees and PC Simulation Categories for Procurement (Section 5.4) to be completed after Industry Days Conference

5.3 Return on Investment (ROI)

Estimating the value of choosing PC Simulation over other alternatives requires a cost and benefits analysis where the indirect, intangible benefits are sometimes difficult or impossible to quantify. Return of investment (ROI) is commonly defined as the ratio of profit/benefit divided by the amount invested and is usually expressed in dollar terms. Intangible benefits of PC Simulation are seldom expressed in terms of dollars. In some situations, cost may not be the most important metric, for example:

- Demonstrating the practice of hazardous procedures –avoiding the loss of life or tactical assets
- Benefits of learner engagement for drill and practice on mission critical procedures, etc.

The following should be considered when calculating ROI:

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Tangible Benefits

- Productivity/throughput
- Personnel cost
- Equipment cost
- Maintenance cost
- Travel expenses
- Facility cost
- Time
- Logistics

Intangible Benefits

- Efficiency
- Safety/health of personnel
- Readiness
- Learning
- Motivational aspects
- Customization
- Risk Mitigation

Factors affecting the cost of developing PC Simulations must be taken into consideration when conducting an ROI. PC Simulations should be procured with the minimum level of fidelity, level of interactivity, object parameter configuration (number of pre-programmed and configurable faults and events), and immersive realism to meet the training need.

Appendix B contains Guidelines for the Comparison of the Life Cycle Costs of Acquiring "Actual" Equipment for Maintenance Training Versus The Acquisition of a Synthetic Maintenance Trainer –for informational purposes.

5.4 Recommended PC Simulation Categories for Acquisitions

.....To be completed after Industry Days Conference

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Appendix A
Learning Levels Appropriate for PC Simulation

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Learning Type		Animation Required to meet training need?	Job Context required to meet training need?	Practice drills required to meet the training need?	Are there complex concept to convey?
Learning Level					
Learning Action Verb	Description	Y/N	Y/N	Y/N	Y/N
Knowledge	The fact or condition of knowing something with familiarity gained through experience or association				
Discrimination Learning	Learning to group similar and dissimilar items according to their distinct characteristics.				
Consolidate	to join together into one whole				
Allocate	to apportion for a specific purpose or to particular persons or things				
Distribute	to divide or separate especially into kinds				
Distinguish	to perceive a difference in : mentally separate				
Discriminate	to mark or perceive the distinguishing or peculiar features of				
Differentiate	to mark or show a difference in : constitute a difference that distinguishes				
Designate	to indicate and set apart for a specific purpose, office, or duty; to call by a distinctive title, term, or expression				
Cross-check	to check from various angles or sources to determine validity or accuracy				
Eliminate	to set aside as unimportant				
Contrast	compare or appraise in respect to differences				

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Extract	to select (excerpts) and copy out or cite; to determine (a mathematical root) by calculation to determine (a mathematical root) by calculation
Confirm	to give new assurance of the validity of : remove doubt about by authoritative act or indisputable fact
Compare	to examine the character or qualities of especially in order to discover resemblances or differences
Collate	to collect, compare carefully in order to verify, and often to integrate or arrange in order
Classify	to arrange in classes
Categorize	to put into a category
Assign	to ascribe as a motive, reason, or cause especially after deliberation
Arrange	to put into a proper order or into a correct or suitable sequence, relationship, or adjustment
Correlate	to present or set forth so as to show relationship
Realign	to reorganize or make new groupings of
Translate	to transfer or turn from one set of symbols into another
Task	to assign a task to
Sort	to put in a certain place or rank according to kind, class, or nature
Separate	to set or keep apart
Select	to choose (as by fitness or excellence) from a number or group : pick out
Schedule	to appoint, assign, or designate for a fixed time
Restate	to state again or in another way
Divide	to separate into two or more parts, areas, or groups
Redistribute	to alter the distribution of
Tune	to adjust for precise functioning
Rank	to determine the relative position of
Organize	to form into a coherent unity or functioning whole
Match	to put in a set possessing equal or harmonizing attributes

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Level	to make (as color) even or uniform
Label	to describe or designate with or as if with a label
Group	to assign to a group
Finalize	to put in final or finished form
Reorganize	to organize again or anew

The learning of verbal or symbolic information (e.g. names, formulas, facts)

Fact Learning

List	to make a list of; include on a list
Answer	to reply in rebuttal, justification, or explanation; to speak or write in reply to
Brief	to give essential information to; to give final precise instructions to
Calculate	to reckon by exercise of practical judgment; to determine by mathematical processes
Define	to determine or identify the essential qualities or meaning of
Elaborate	to expand something in detail
Identify	to establish the identity of
Advise	to give information or notice to; to give advice to
Instruct	to give knowledge to
Tell	to express in words
Name	to give a name to; to mention or identify by name
Read	to receive or take in the sense of (as letters or symbols) especially by sight or touch
Recall	to bring back to mind
Recommend	to present as worthy of acceptance or trial
Recount	to relate in detail
Specify	to name or state explicitly or in detail
State	to express the particulars of especially in words
Inform	to communicate knowledge to

Problem Solving

Learning to synthesize lower levels of knowledge for the resolution of problems.

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Resolve	to deal with successfully : clear up
Apply	to put to use especially for some practical purpose
Annotate	to make or furnish critical or explanatory notes or comment
Analyze	to study or determine the nature and relationship of the parts of by analysis
Use	the act or practice of employing something
Triage	the assigning of priority order to projects on the basis of where funds and resources can be best used or are most needed
Synthesize	to combine or produce by synthesis (deductive reasoning)
Summarize	to tell in or reduce to a summary
Solve	to find a solution, explanation, or answer for
Infer	to derive as a conclusion from facts or premises
Revise	to make a new, amended, improved, or up-to-date version
Conclude	to reach as a logically necessary end by reasoning : infer on the basis of evidence
Project	to plan, figure, or estimate for the future
Produce	to compose, create, or bring out by intellectual or physical effort
Predict	foretell on the basis of observation, experience, or scientific reason
Plan	to devise or project the realization or achievement of
Modify	to make basic or fundamental changes in often to give a new orientation to or to serve a new end
Manipulate	to manage or utilize skillfully
Locate	to determine or indicate the place, site, or limits of; to find or fix the place of especially in a sequence
Investigate	to observe or study by close examination and systematic inquiry
Search	to look into or over carefully or thoroughly in an effort to find or discover something
Determine	to settle or decide by choice of alternatives or possibilities

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Hypothesize	to adopt as a hypothesis (a tentative assumption made in order to draw out and test its logical or empirical consequences)
Generate	to define or originate (as a mathematical or linguistic set or structure) by the application of one or more rules or operations
Generalize	to give general applicability to
Find	to discover by study or experiment
Extend	to increase the scope, meaning, or application of
Explain	to give the reason for or cause of; to make plain or understandable
Effect	to cause to come into being
Draft	to draw the preliminary sketch, version, or plan of
Change	to make different in some particular; to give a different position, course, or direction to
Diagram	to represent by or put into the form of a diagram
Combine	to bring into such close relationship as to obscure individual characters
Design	to conceive and plan out in the mind; to devise for a specific function or end
Derive	to take, receive, or obtain especially from a specified source
Defend	to maintain or support in the face of argument or hostile criticism
Decide	to select as a course of action
Debug	to eliminate errors in or malfunctions of
Criticize	to consider the merits and demerits of and judge accordingly
Create	to produce or bring about by a course of action or behavior
Convert	to change from one form or function to another; to bring over from one belief, view, or party to another
Illustrate	to provide with visual features intended to explain or decorate
Discover	to obtain sight or knowledge of for the first time

Procedure learning **Learning to perform step-by-step actions in the proper sequence.**

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Set-up	to put (a machine) in readiness or adjustment for a tooling operation
Implement	to give practical effect to and ensure of actual fulfillment by concrete measures
Resume	to return to or begin again after interruption
Pause	to cause to stop temporarily
Stop	to cause to cease
Start	to begin an activity or undertaking; especially : to begin work
Initiate	to cause or facilitate the beginning of
Delete	to eliminate especially by blotting out, cutting out, or erasing
Edit	to alter, adapt, or refine especially to bring about conformity to a standard or to suit a particular purpose
Condense	to make denser or more compact
Check	to inspect, examine, or look at appraisingly
Rule Learning	Learning to use two or more facts in a manner that will provide regularity of behavior in an infinite variation of situations.
Route	to divert in a specified direction
Outline	to indicate the principal features or different parts of
Measure	to allot or apportion in measured amounts
Forward	advocating an advanced policy in the direction of what is considered progress
Format	to arrange in a particular shape, size, and general makeup
Evaluate	to determine the significance, worth, or condition of usually by careful appraisal and study
Estimate	to determine roughly the size, extent, or nature of
Encrypt	to convert (a message) into cipher
Compute	to determine especially by mathematical means
Compose	to arrange in proper or orderly form
Compile	to compose out of materials from other documents; to build up gradually
Appraise	to evaluate the worth, significance, or status of

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Skills
The ability to use one's knowledge effectively and readily in execution or performance. Dexterity or coordination especially in the execution of learned physical tasks.

Adaptation
Learning to modify a complex physical skill to accommodate a new situation

Deploy	to spread out, utilize, or arrange especially strategically
Load	to put a load in or on; to put a load or charge in (a device or piece of equipment)
Lead	to direct the operations, activity, or performance
Lay	to prepare or position for action or operation
Infiltrate	to enter or become established in gradually or unobtrusively usually for subversive purposes
Evade	to elude by dexterity or stratagem
Acclimatize	to adapt to a new temperature, altitude, climate, environment, or situation
Direct	to carry out the organizing, energizing, and supervising of
Occupy	to take or hold possession or control of
Conduct	to bring by or as if by leading
Bypass	to avoid by means of a bypass; to cause to follow a bypass
Attack	to set upon or work against forcefully
Ambush	to station in ambush; to attack from an ambush
Adapt	to make fit (as for a specific or new use or situation) often by modification
Accommodate	to make fit, suitable, or congruous
Draw	to produce a likeness or representation of by making lines on a surface
Protect	to cover or shield from exposure, injury, or destruction
Temper	to dilute, qualify, or soften by the addition or influence of something else
Tailor	to make or adapt to suit a special need or purpose
Suppress	to put down by authority or force
Relieve	to release from a post, station, or duty

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Reduce	to diminish in size, amount, extent, or number
Recover	to bring back to normal position or condition
Map	to delineate as if on a map; to plan in detail
Queue	to arrange or form in a queue
Neutralize	to counteract the activity or effect of : make ineffective
Program	to predetermine the thinking, behavior, or operations of as if by computer programming
Prevent	to keep from happening or existing
Patrol	to carry out a patrol of
Pack	to make into a compact bundle; to put in a protective container
Orient	to acquaint with the existing situation or environment
Train	to form by instruction, discipline, or drill
Reconcile	to make consistent or congruous
Continuous Movement	
Learning to track, make compensatory movements based on feedback.	
Traverse	to go or travel across or over; to move (a gun) to right or left on a pivot
Track	to observe or plot the moving path of (as a spacecraft or missile) instrumentally
Take-off	to start off or away
Steer	to control the course of
Regulate	to fix or adjust the time, amount, degree, or rate of
Maneuver	to perform a movement in military or naval tactics in order to secure an advantage; to make a series of changes in direction and position for a specific purpose
Land	to set or put on shore from a ship; to set down after conveying
Hover	to remain suspended over a place or object; to move to and fro near a place : fluctuate around a given point
Guide	to act as a guide to : direct in a way or course
Follow	to go, proceed, or come after
Control	to exercise restraining or directing influence over
Advance	to bring or move forward

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Learns manual dexterity in the performance of physical skills.	
Gross Motor Skills	
Pull	to exert force upon so as to cause or tend to cause motion toward the force
Carry	to move while supporting; to transfer from one place to another
Creep	to slip or gradually shift position
Depart	to go away from
Fall	to descend freely by the force of gravity
Fire	to apply fire or fuel to; to propel from or as if from a gun
Hold	to have or maintain in the grasp
Assault	to make an assault on
Lift	to raise from a lower to a higher position
Wear	to bear or have on the person
Run	to go steadily by springing steps so that both feet leave the ground for an instant in each step
Stay	to stop or delay the proceeding or advance of by or as if by interposing an obstacle; to secure upright with or as if with stays
Swim	to propel oneself in water by natural means (as movements of the limbs, fins, or tail)
Throw	to propel through the air by a forward motion of the hand and arm
Turn	to cause to move around an axis or a center : make rotate or revolve
Twist	to turn or change shape under torsion
Jump	to spring free from the ground or other base by the muscular action of feet and legs
Learning to perform a complex physical skill with confidence and proficiency	
Mechanism	
Enter	to come or go into; to put in
Access	gain access to
Fuel	to provide with fuel
Fit	to insert or adjust until correctly in place

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Fill-out	to give necessary or recently acquired information to
Evacuate	to remove the contents of
Harden	to make hard or harder;to protect from blast, heat, or radiation (as by a thick barrier or placement underground)
Exchange	the act or process of substituting one thing for another
Initialize	to set to a starting position, value, or configuration
Energize	to impart energy to
Engage	to begin and carry on an enterprise or activity
Employ	to make use of (someone or something inactive)
Emlace	to put into position
Elevate	to lift up
Egress	to go or come out
Establish	to make firm or stable; to institute
Isolate	to set apart from others
Mount	to attach to a support; to arrange or assemble for use or display
Manage	to handle or direct with a degree of skill; to make and keep compliant
Maintain	to keep in an existing state (as of repair, efficiency, or validity) : preserve from failure or decline
Lubricate	to make smooth or slippery; to apply a lubricant to
Log	to make a note or record of : enter details of or about in a log
Ground	to connect electrically with a ground
Issue	to put forth or distribute usually officially
Dispose	to put in place : set in readiness
Intercept	to stop, seize, or interrupt in progress or course or before arrival
Integrate	to form, coordinate, or blend into a functioning or unified whole
Install	to set up for use or service
Inspect	to view closely in critical appraisal
Insert	to put or introduce into the body of something
Input	to enter (as data) into a computer or data processing system

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Launch	to release, catapult, or send off
Assemble	to fit together the parts of
Clean	to rid of dirt, impurities, or extraneous matter
Center	to place or fix at or around a center or central area or position
Camouflage	to conceal or disguise by camouflage
Calibrate	to adjust precisely for a particular function
Breach	to make a breach in
Drive	to impart a forward motion to by physical force
Attach	to make fast (as by tying or gluing)
Collect	to bring together into one body or place
Archive	to file or collect (as records or documents) in or as if in an archive
Align	to bring into line or alignment; to be in or come into precise adjustment or correct relative position
Administer	to manage or supervise the execution, use, or conduct of
Adjust	to bring to a more satisfactory state; to bring the parts of to a true or more effective relative position
Actuate	to put into mechanical action or motion
Activate	to make active or more active; to set up or formally institute (as a military unit) with the necessary personnel and equipment
Balance	to bring to a state or position of equipoise; to bring into harmony or proportion
Destroy	to ruin the structure, organic existence, or condition of
Obtain	to gain or attain usually by planned action or effort
Display	to put or spread before the view
Dispatch	to send off or away with promptness or speed
Dismantle	to take to pieces; also : to destroy the integrity or functioning of
Disengage	to release from something that engages or involves
Disconnect	to sever the connection of or between
Clear	to free from what obstructs or is unneeded
Diagnose	to analyze the cause or nature of
Close	to move so as to bar passage through something

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Deliver	to take and hand over to or leave for another
Decontaminate	to rid of contamination (as radioactive material)
Debrief	to interrogate (as a pilot) usually upon return (as from a mission) in order to obtain useful information
Cover	to place or set a cover or covering over
Connect	to join or fasten together usually by something intervening
Disseminate	to disperse throughout
Disassemble	to take apart
Splint	to support and immobilize with a splint
Supervise	to oversee
Submit	to present or propose to another for review, consideration, or decision
Strike	to bring into forceful contact; to make a military attack on
Stow	to put away for future use; to dispose in an orderly fashion
Store	to stock against a future time; to place or leave in location
Save	to put aside as a store or reserve
Squeeze	to exert pressure especially on opposite sides of
Take	to get into one's hands or into one's possession, power, or control
Signal	to communicate or indicate by or as if by signals
Sight	to look at through or as if through a sight; especially : to test for straightness
Shutdown	to cause the cessation or suspension of an operation or activity
Service	to repair or provide maintenance for
Send	to cause to go
Move	to change the place or position of
Stockpile	to place or store in or on a stockpile
Transmit	to send or convey from one person or place to another
Write	to form (as words) by inscribing the characters or symbols of on a surface
Update	to bring up to date
Utilize	to make use of : turn to practical use or account

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Unload	to take off
Type	to produce (as a character or document) on a typewriter
Troubleshoot	to investigate or deal with in the role of troubleshooter
Support	to hold up or serve as a foundation or prop for; to promote the interests or cause of
Transport	to transfer or convey from one place to another
Sweep	to remove from a surface with or as if with a broom or brush; to touch in passing with a swift continuous movement
Transfer	to convey from one person, place, or situation to another
Trace	to follow or study out in detail or step by step
Tighten	to make tight or tighter
Test	to put to test or proof
Tap	to strike lightly especially with a slight sound
Rotate	to cause to turn or move about an axis or a center
Treat	to act upon with some agent especially to improve or alter
Perform	to do in a formal manner or according to prescribed ritual
Process	to subject to or handle through an established usually routine set of procedures
Pressurize	to confine the contents of under a pressure greater than that of the outside atmosphere
Press	to act upon through steady pushing or thrusting force exerted in contact
Post	to publish, announce, or advertise by or as if by use of a placard; to affix to a usual place (as a wall) for public notices
Position	to put in proper position
Secure	to relieve from exposure to danger; to release (naval personnel) from work or duty
Plot	to locate (a point) by means of coordinates; to mark or note on or as if on a map or chart
Publish	to disseminate to the public; to produce or release for distribution
Park	to place, settle, or establish especially for a considerable time

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Place	to put in or as if in a particular place or position
Order	to put in order
Operate	to cause to function; to put or keep in operation
Open	to make available for entry or passage by turning back (as a barrier) or removing (as a cover or an obstruction)
Zero	to determine or adjust the zero of
Police	to supervise the operation, execution, or administration of to prevent or detect and prosecute violations of rules and regulations; to make clean and put in order
Release	to set free from restraint, confinement, or servitude
Reset	to set again or anew; to change the reading of: often to zero
Return	to bring, send, or put back to a former or proper place
Retrieve	to get and bring back
Replenish	to fill or build up again
Replace	to put something new in the place of
Repair	to restore by replacing a part or putting together what is torn or broken
Procure	to get possession of : obtain by particular care and effort
Relocate	to locate again : establish or lay out in a new place
Provide	to supply or make available
Record	to set down in writing : furnish written evidence of
Refuel	to provide with additional fuel
Reach	to touch or grasp by extending a part of the body (as a hand) or an object
Range	to rove over or through
Raise	to set upright by lifting or building
Navigate	to make one's way over or through; to sail over, on, or through; to operate or control the course of (as an airplane)
Remove	to move by lifting, pushing aside, or taking away or off

Origination **Learning to create a new complex physical skill to accommodate a new situation.**

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Originate	to give rise to; initiate
Make	to cause to happen to or be experienced by someone; to cause to exist, occur, or appear
Invent	to produce (as something useful) for the first time through the use of the imagination or of ingenious thinking and experiment
Correct	to alter or adjust so as to bring to some standard or required condition
Contrive	to form or create in an artistic or ingenious manner
Construct	to make or form by combining or arranging parts or elements
Cause	to effect by command, authority, or force
Perception	Perception of sensory stimuli that translates into physical performance.
Visualize	to see or form a mental image of
Taste	to ascertain the flavor of by taking a little into the mouth
Smell	to perceive the odor or scent of through stimuli affecting the olfactory nerves
See	to perceive by the eye
Scan	to glance from point to point of often hastily, casually, or in search of a particular item
Hear	to perceive or apprehend by the ear; to gain knowledge of by hearing
Feel	to handle or touch in order to examine, test, or explore some quality; to perceive by a physical sensation coming from discrete end organs
Detect	to discover the true character of
Readiness	Learning to have Readiness to take a particular action.
Set	to cause to assume a specified posture or position
Ready	to make ready
Prime	to put into working order by filling or charging with something

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Prepare	to make ready beforehand for some purpose, use, or activity
Guard	to watch over so as to prevent escape, disclosure, or indiscretion
Delay	to stop, detain, or hinder for a time
Cross	to move, pass, or extend across something
Challenge	to confront or defy boldly; to order to halt and prove identity
Assist	to give support or aid

Attitude **A mental position with regard to a fact or state. A feeling or emotion toward a fact or state**

Learning and demonstrating the mental preparedness to make decisions by using prioritized strategies and tactics in response to normal, abnormal, and emergency condition cues associated with the performance of an operational procedure.

Competence

Serve	to comply with the commands or demands of
Prescribe	to lay down as a guide, direction, or rule of action
Influence	to affect or alter by indirect or intangible means
Enforce	to carry out effectively
Ensure	to make sure, certain, or safe
Coordinate	to bring into a common action, movement, or condition
Command	to direct authoritatively
Assume	to take control of
Alter	to make different without changing into something else
Allow	to reckon as a deduction or an addition; to assign as a share or suitable amount

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Learning and demonstrating the mental preparedness to make decisions by generating the results expected upon completion of a prioritized strategies or tactics in response to normal, abnormal, and emergency cues associated with the performance of an operational procedure, and the ability to generate new prioritized strategies and tactics in response to abnormal or emergency cues.

Innovation

Innovate	to introduce as or as if new
Imagine	to form a mental image of (something not present)
Formulate	to put into a systematized statement or expression
Devise	to form in the mind by new combinations or applications of ideas or principles
Develop	to set forth or make clear by degrees or in detail
Conjecture	to arrive at by a conclusion deduced by surmise or guesswork
Conceive	to apprehend by reason or imagination; to take into one's mind

Learning and demonstrating the ability to perceive the normal, abnormal, and emergency condition cues associated with the performance of an operational procedure. Situational Awareness of operational condition cues.

Receiving

Wait	to stay in place in expectation of
Recognize	to perceive to be something or someone previously known
Perceive	to attain awareness or understanding of
Observe	to watch carefully especially with attention to details or behavior for the purpose of arriving at a judgment
Monitor	to watch, keep track of, or check usually for a special purpose
Listen	to give ear to
Attend	to pay attention to

Learning and demonstrating mental preparedness to encode operational cues as indicators of normal, abnormal, and emergency conditions associated with the performance of an operational procedure.

Responding

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Execute	to carry out fully : put completely into effect
Achieve	to carry out successfully; to attain a desired end or aim : become successful
Acknowledge	to disclose knowledge of or agreement with
Announce	to make known publicly; to indicate beforehand
Ask	to call on for an answer; to make a request of
Communicate	to convey knowledge of or information about
Complete	to make whole or perfect; to carry out successfully
Comply	to conform or adapt one's actions to another's wishes, to a rule, or to necessity
Demonstrate	to prove or make clear by reasoning or evidence; to illustrate and explain especially with many examples
Accomplish	to bring about (a result) by effort; to bring to completion
Encode	to convert (as a body of information) from one system of communication into another; especially : to convert (a message) into code
Show	to demonstrate or establish by argument or reasoning
Give	to present to view or observation
Indicate	to point out or point to
Interpret	to explain or tell the meaning of : present in understandable terms
Notify	to give notice of or report the occurrence of
Obey rules	to follow the commands or guidance of; to conform to or comply with
React	to respond to a stimulus
Report	to give a formal or official account or statement of
Request	to make a request to or of
Respond	to say something in return : make an answer
Describe	to represent or give an account of in words

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Learning and demonstrating the ability to judge the worth or quality of normal, abnormal, and emergency cues associated with the performance of an operational procedure.

Valuing

Prioritize	to list or rate (as projects or goals) in order of priority
Appreciate	to grasp the nature, worth, quality, or significance of; to judge with heightened perception or understanding
Approve	to have or express a favorable opinion of; to accept as satisfactory
Assess	to determine the importance, size, or value of
Authenticate	to prove or serve to prove the authenticity of
Cancel	to destroy the force, effectiveness, or validity of
Choose	to select freely and after consideration
Believe	to accept as true, genuine, or real
Alert	to call to a state of readiness; to make aware of
Justify	to prove or show to be just, right, or reasonable
Reassess	to redetermine the importance, size, or value of
Propose	to set forth for acceptance or rejection
Qualify	to characterize by naming an attribute
Review	to examine or study again
Share	to divide and distribute in shares
Study	to read in detail especially with the intention of learning
Validate	to support or corroborate on a sound or authoritative basis
Verify	to establish the truth, accuracy, or reality of
Judge	to form an opinion about through careful weighing of evidence and testing of premises

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Appendix B

ROI Considerations based on NETC Guidelines

(Guidelines for the Comparison of the Life Cycle Costs Of Acquiring "Actual"
Equipment for Maintenance Training Versus The Acquisition of a Synthetic
Maintenance Trainer)

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"Actual Equipment" Maintenance Trainer

Business Case Data Sheet
Life Cycle Cost Estimate

Part One – Training System Acquisition Calculation

1. System Acquisition Cost (Manufacturers' system price ...include all taxes and shipping costs...multiply by the number of systems to be acquired...include simulators and stimulators if needed).	
2. System Spares Cost (the value of the spares that will be used to keep the training system(s) fully functional during the years that it (they) will be used for training...if unknown, use 30% of the value in 1 above).	
3. Fault Insertion Devices (the value of all FIDs that will be acquired for the training system(s)).	
4. System Installation Costs (the value of the following: cables and connectors, site preparation costs (electrical, plumbing, painting, refurbishment, construction, etc.) ... e.g., all costs associated with the installation and set-to-work of the training system(s)...Note: assume that all this work is contracted out).	
5. Tools and Test Equipment (the value of all the tools and test equipment needed to support the training system(s)).	
6. System(s) Upgrade Costs (the estimated value of all upgrade costs associated with keeping the trainer(s) in the identical configuration as operational systems...include capital acquisition and installation costs).	
Subtotal:	

Part Two – In-Service Support Cost Calculation

1. Support Staff Costs (include an estimate for the costs of the following support staffs: maintenance, procurement, contracting, stores-people, etc....many of these support personnel will support this training system(s) on a part-time basis...estimate the total annual support and multiply by the number of years that the system(s) will be in-service...then multiply by a reasonable hourly rate).	
2. Spares Support Costs (include an estimate for the following costs: the "rental or construction" value of the space needed to be allocated for the system spares...multiply annual rate by the number of years that the system(s) will be in-service...add in the estimated packaging, handling, shipping and insurance costs associated with sending failed components out for repair).	
3. "Hotel Service" Costs (estimate the value of all electrical and water charges attributed to the operation of the training system(s)...estimate the costs associated with the "floor space" allocated to the Training and Test Equipment).	
4. Tools and Test Equipment (estimate the costs associated with the replacement, refurbishment and calibration of all system(s) tools and test equipment during the life of the training system(s)).	
5. Student Travel and Living Costs (estimate the costs for travel, accommodation, meals and other costs that will be spent to have students come to the training establishment for training on this system).	
Subtotal:	

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Part Three – Discretionary Cost Calculations

1. Refresher Training Costs (if it is assessed that high system reliability will require a maintainer to undergo refresher training (to counter skill fade), then estimate the costs associated with satisfying this requirement...typical costs include: Travel and Living Costs, additional instructor requirements, additional use of spares, increased support staff time, etc.).	
2. Replacement and Addition of Fault Insertion Devices (estimate the cost of replacing or repairing faulty FIDs and estimate the costs of acquiring new FIDs to allow the instructors to teach additional faults).	
3.	
4.	
5.	
Subtotal	

Part Four – Actual Equipment - Final Cost Estimate

Part One – Subtotal	
Part Two – Subtotal	
Part Three – Subtotal	
Total	

Life-Cycle Cost Estimate

Comments:

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SYNTHETIC MAINTENANCE TRAINER

Business Case Data Sheet Life-Cycle Cost Estimate

Part One – Training System Acquisition Calculation

1. System Acquisition Cost (Developers' system price...include all taxes and shipping costs...include the cost of acquiring multiple copies...include the cost of any Part Task Trainers (PTT) (if applicable)).	
2. System Spares Cost (only applicable to PTT equipment).	
3. Fault Insertion Devices (if needed for a PTT).	
4. System Installation Costs (should be "not applicable" unless costs for PTT or the establishment of an electronic classroom is included).	
5. Tools and Test Equipment (the value of all the tools and test equipment needed to support the training system(s)).	
6. System(s) Upgrade Costs (the estimated value of all upgrade costs associated with keeping the trainer(s) in the identical configuration as operational systems...include capital acquisition and installation costs).	
Subtotal:	

Part Two – In-Service Support Cost Calculation

1. Support Staff Costs (include an estimate for the costs of the following support staffs: maintenance, procurement, contracting, stores-people, etc....many of these support personnel will support this training system(s) on a part-time basis...estimate the total annual support and multiply by the number of years that the system(s) will be in-service ...then multiply by a reasonable hourly rate).	
2. Spares Support Costs (include an estimate for the following costs: the "rental or construction" value of the space needed to be allocated for the system spares...multiply annual rate by the number of years that the system(s) will be in-service...add in the estimated packaging, handling, shipping and insurance costs associated with sending failed components out for repair).	
3. "Hotel Service" Costs (estimate the value of all electrical and water charges attributed to the operation of the training system(s)...estimate the costs associated with the "floor space" allocated to the Training and Test Equipment).	
4. Tools and Test Equipment (estimate the costs associated with the replacement, refurbishment and calibration of all system(s) tools and test equipment during the life of the training system(s)).	
5. Student Travel and Living Costs (estimate the costs for travel, accommodation, meals and other costs that will be spent to have students come to the training establishment for training on this system).	
Subtotal:	

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Part Three – Discretionary Cost Calculations

1. Course Length Difference (estimate the value of the time that would be saved if a course could be shortened, if it were possible to provide each student with his or her own individual training system and if an assumption were made that each system (and its associated tools and test equipment) would always be available when required).	
2. Refresher Training Costs (if it is assessed that high system reliability will require a maintainer to undergo refresher training (to counter skill fade), then estimate the costs associated with satisfying this requirement ...typical costs include: travel and living costs, additional instructor requirements, additional use of spares, increased support staff time, etc.).	
3. Replacement and Addition of Fault Insertion Devices (estimate the cost of replacing or repairing faulty FIDs and estimate the costs of acquiring new FIDs to allow the instructors to teach additional faults).	
4.	
5.	
Subtotal	

Part Four – Synthetic Trainer - Final Cost Estimate

Part One – Subtotal	
Part Two – Subtotal	
Part Three – Subtotal	
Total	

Comments:

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